

SOUND REDUCED ROTARY VANE COMPRESSOR

Field

This invention relates to rotary vane compressors and more particularly to an improved compressor which exhibits low sound emission due to a combination
5 of improved elements.

Background

Rotary vane compressors are used in a variety of applications. One such
10 compressor includes a rotor having vane receiving slots with a vane in each slot. The rotor is rotated, in an eccentric manner, in a cavity within a body to produce compressed gas. One major application is in home sewage treatment. There the rotary vane compressor is used to pump air into home sewage treatment tanks to provide bacteria growth, which in turn, will break down the effluent in the tank.
15 The compressor is typically located outside, next to the house and operates continuously.

A typical rotary vane compressor is sold by Gast Manufacturing, Inc. of Benton Harbor, Michigan, 49023-0097 as its "23 Series". These compressors usually include the following components: (1) a motor in a vented housing
20 having a bearing mounted drive shaft; (2) a vented back plate or closure for the motor housing; (3) a rear plate mounted to the housing and through which the shaft extends; (4) an inlet ring between the motor housing and rear plate; (5) a rotor with vanes mounted to the drive shaft, and positioned within a body; (6) a vented shroud surrounding the body which abuts the motor housing; (6) a front

plate that bears against the body and rotor; and (7) a muffler box positioned against the front plate and through which air enters and exits the compressor.

The muffler box, front plate, body, rear plate and motor housing are secured together. The major moving parts are the motor, drive shaft, bearings and
5 rotor with vanes all of which produce sound. However, vibration of the non-moving parts is also important. The compressor emits sound during operation, which due to its 24-hour operation can become irritating over time.

It is an object of this invention to reduce the sound of the compressor when it operates.

10 This and other objects of the invention will become apparent from the following description and independent claims.

Summary

15 The compressor of this invention is quieter in operation and exhibits reduced sound emission. The compressor operates at sound levels of less than about 50dBA (decibels) at one meter. This low sound level has been achieved by various improvements taken in combination. These include improvements relate to the motor, a shorter non-vented motor housing, a non-vented back plate for the
20 motor housing, improved bearings for the drive shaft, and a change in the rotor carrying body such as an increased mass, a solid or non-vented shroud made of a laminated material that surrounds the body, modifications in the vane carrying rotor and optionally an improved muffler box made out of a cast iron, zinc or magnesium casting.

Description of the Drawings

Figure 1 is an isometric view of a sound-reduced rotary vane compressor;

5 Figure 2 is a back view of the compressor of Figure 1;

Figure 3 is an exploded isometric view of components of the compressor of Figure 1;

Figure 4 is a top or elevational and exploded view of components shown in Figure 3;

10 Figure 5 is a front view of an improved inlet ring used in the compressor of Figure 1;

Figure 6 is a perspective view of the body used in the compressor of Figure 1;

Figure 7 is a top view of the body of Figure 6;

15 Figure 8 is a front view of the body of Figure 6;

Figure 9 is a front view of the vane-carrying rotor used in the compressor of Figure 1;

Figure 10 is a side view of the rotor used in the compressor of Figure 1;

20 Figure 11 is a perspective view of a non-vented cylindrical shroud used in the compressor of Figure 1;

Figure 12 is a sectional view of the shroud taken along line 12-12 of Figure 11 and showing the laminated construction of the shroud.

Description

The compressor 10 is shown in Figure 1. Externally the compressor has a solid, non-vented motor housing 12, a non-vented back 13, a rear plate 14, a solid non-vented shroud 16, a front plate 18 and a muffler box 20. The components are bolted together so as to form a unit. Two ports 22 and 24 are provided in the muffler box for the entry of air and exit of compressed air. Muffler constructions 26 and 28 are provided for use in the muffler box. The rear or back 13 of the compressor is shown in Figure 2 and includes a solid non-vented plate.

Referring now to Figure 3, an exploded view of the compressor is shown and the internal mechanism can be seen. In the housing there is positioned an electric motor which can be generally characterized as a one-sixth horsepower motor, having a four pole stator and a six pole rotor. The housing 12 has a maximum length of about 5.22 inches so as to reduce the vibrations. The motor's rotor drives a drive shaft 30 which is mounted on a plurality of deep groove ball bearings 32.

An inlet ring 34 is positioned against the motor housing 12. There is provided the rear plate 14 which includes a centrally positioned bolting and bearing support section 38 which is held in position by a plurality of webs such as 40. It is seen that the drive shaft 30 is also supported by a second set of bearings 42 which is secured to the section 38. The rear plate 14 is secured to the motor housing with the inlet ring 34 positioned therebetween like a gasket. Bolts such as 44 from the motor housing are secured to the periphery of the rear plate 14.

The shroud 16 is non-vented and made of a laminated material and fits against the rear plate 14.

The body 36 defines a rotor cavity 46 therein, fits within the shroud 16, has a radius of at least about 2.62 inches, a minimum weight of about 4.63 pounds, and is made of a gray iron casting, more specifically SAE J4321 G2500. A rotor and vane assembly 48 is positioned within the cavity 46. The drive shaft 30 extends to and engages the rotor and rotates the assembly 48. The assembly 48 includes the rotor 50 and four vane receiving slots such as 52 within each of which there is a positioned a vane 54. It will be appreciated that the motor rotates the drive shaft which, in turn, rotates the assembly 48 for compressing incoming air and expelling compressed air. When the rotor is rotated, each vane can slide within a rotor slot and can engage the cavity wall or body 36. The front plate 18 engages the front face of the body 36 and is divided into two chambers or sections 58 and 60 by the by a central rib 62 and peripheral edge 64. The muffler box 20 which is preferably made from a gray iron, but can be made from die cast aluminum, is secured against the front end plate. The muffler box defines the exit and inlet ports 22 and 24 and each communicates with a chamber 58 or 60. The muffler box is deep enough to receive the muffler elements 26 and 28.

Elements or components of the compressor are also seen in Figure 4 and include the motor housing 12, the drive shaft 30, the inlet ring 34, the rear plate 14, the shroud 16, the rotor assembly 48, the body 36, the front plate 18 and muffler box 20.

Inlet Ring

The inlet ring 34 is seen in Figure 5. The ring 34 has a small wall
5 thickness 66 [i.e., the difference between the outside diameter (OD) and inside
diameter (ID)] of about 1.25 inches and is made of 20 gage cold rolled steel. The
ring is positioned between the motor housing 12 and the rear plate 14. The ring is
crushable and acts like a gasket to seal against both the housing and plate. The
ring OD is fixed by the compressor size and the ID is increased as much as
10 possible so as to reduce vibration and maintain sealing.

The Body

The body 36 is shown in Figures 6, 7 and 8. The body has a positioning
15 groove 62 located at the top thereof, has an increased mass or, a weight of about
4.63 pounds, as well as an increased outer radius 68 of about 2.62 inches. The
body is fabricated of gray iron, as specified hereinbefore, which exhibits sound-
dampening characteristics. In addition, the size, weight and mass of the body is
maximized so as to maximize sound dampening. The outside diameter is
20 increased, but is limited by the size of the compressor. The inside diameter or
cavity is maintained for cooperation with the rotor assembly.

Rotor

The rotor body 50 which has vane-carrying slots such as 52 is shown in
25 Figures 3 and 9. Each of the slots carries a vane, extends into the rotor body, is at
right angles to an adjacent vane slot and forms a chord-like construction which

extends from the circumference or periphery of the rotor into the rotor body as shown. The positioning of the slot relative to the center and relative to the other slots is important in reducing the sound of operation. The intersection of the slot or its centerline with the circumference is at about a 24° angle relative to a line
5 extending through the center of the rotor and normal to an adjacent slot. The angular relation can vary between 23° and 25°. This angular relationship is important as it permits vane movement in the slot and reduces vane bounce during rotation. The mass or weight of each vane is important to maximize radial force. The weight of the vane herein is about 6.75 grams. The combination of vane
10 mass and angular relation also reduces vane bounce and noise.

The Shroud

Figures 10, 11 and 12 show the shroud 16. The shroud 16 is a cylindrical
15 member which fits about the body 18 and engages the rear plate 14 and the front plate 56. The shroud is a solid non-vented member which can be made of a laminated structure seen in Figure 12. The laminated structure includes an outer metal layer 70, an inner metal layer 72 and an intermediate viscous layer 74. The solid or non-vented structure and the laminated structure contributes to the
20 dampening or sound reduction. The inner and outer layers are 24 to 26 gauge Galvaneal steel (Galvaneal steel is electro-galvanized steel which is made for painting) and the sound dampening material is a viscous material such as Acrylic pressure sensitive adhesive. The laminate can be purchased from Roush Anatrol

Main Office, 11953 Market Street, Livonia, MI 48100, under the trade name Anatrol 980.

Bearings

- 5 The bearings such as 32 and 42 are referred to as deep groove ball bearings (See NSK catalog, Rolling Bearings, Cat. No. A 140b, 19933-10 Printed in Japan, Copyright NSK Ltd. 1989) are sealed and utilize a grease or lubricant to dampen sound. This grease or lubricant is a polyurea grease (available as POLYREX EM, from Exxon Mobile Corporation, 3225 Gallows Road, Fairfax, VA 22037. The combination of the deep groove bearing and grease reduce the sound of operation.
- 10

Motor and Housing

- 15 The motor itself is one-sixth horse power, 6-pole rotor and 4-pole stator type. The motor housing is less than about 5.22 inches in length and is solid or non-vented. Sound emanating from the motor during operation has been minimized.

- The back or closure 13 for the motor housing 12 is a solid non-vented member which is secured to the housing. The fact that the back is solid and non-vented minimizes sound emanating from the rear of the compressor.
- 20

Summary

- 25 The combination of above-identified factors reduces the sound emitted from the compressor during operation to about 50 dB at 1 meter. Those factors

- include the solid non-vented motor housing 12, the solid non-vented housing back 13, the 6-pole rotor 4-pole stator motor, the deep groove bearings 32 and 42 and lubricant, the rotor-vane angular relationship and vane weight or mass, the increased body size and mass 18 and the non-vented solid or laminated shroud 16.
- 5 In addition, the muffler 20 can be made of various materials so as to enhance the sound deadening property.

It will be appreciated that numerous changes and modifications can be made to the embodiments detailed above.